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(54) BLADE OF HOCKEY STICK AND OTHER COMPOSITE REINFORCED STRUCTURE

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1063747 - ABSTRACT OF THE DISCLOSURE - OCT -2 1979

A non-wooden blade of hockey stick which is particularly adapted to at least match the advantages of the wooden blade of the hockey stick now used by the professional hockey player, in particular the resilience, impact resistance and relative weight or density. This non-wooden blade is characterized by a core of a syntactic foam composition which is particularly suited to produce a blade and a hockey stick having the desired characteristics and which forms a blade in cooperation with a pair of outer fiberglass laminations having a majority of fibers extending lengthwise of the blade. This core is made of thermoset polyester or epoxy resin with hollow microspheres of phenolic plastic or glass, and with short independent fibers of polyester, polyamide or fiberglass. Preferably, a monofilament is wound around the outer laminations to positively prevent separation of the latter from the core. Also, an adhesion promoter is preferably added to the resin to improve the adherence of the resin to the microspheres.

This invention relates to a composite reinforced structure and, more particularly, to a blade of hockey stick,which blade is of the type made of such composite reinforced structure.

It may be useful to point out that the professionalism in sport and, in particular, in hockey, calls for more sophisticated equipment wherein the shape, dimensions, weight, proportions and dynamic characteristics must be strictly considered and abided by to manufacture a successful product. The professional hockey players, for instance, have become very selective for the hockey stick they will play with, and this imposes stringent requirements on the manufacture of hockey sticks. For instance, the blade of a hockey stick must conciliate opposing characteristics such as weight and resistance with lateral thickness and resilience. For example, now the professional hockey stick, as a whole, weighs some 630 grams or 22 ounces and has a wooden blade which weighs some 120 grams or 4.25 ounces, which has a lower edge that must be as thin as possible and currently is only 0.370 inch thick and has a lateral curve of up to one-half inch.

Up to the last decade or so, the hockey sticks were traditionally made of selected woods. In recent years, there have been proposed and patented different alternatives to the traditional hockey stick, either to supplement the attributes of the traditionally used woods or to shift to the use of lower grade woods.

In particular, it has previously been proposed to make at least part of a hockey stick of some plastic and to use fiberglass to provide the necessary reinforcement and resilience. However, in all previous attempts to improve and update the construction of a hockey stick, apparently, insufficient consideration has been given to the blade per se and, in particular, to the weight of the blade in itself and in relation to the weight of the handle or to the total weight of the hockey stick.

The anterior hockey sticks which have been made with a non-wooden blade have not satisfied the afore-mentioned requirements and, therefore, have not been accepted by the professional players. Besides,

such non-wooden blade produces an unusual metallic sound impact which is resented by the players.

Other sport equipments have requirements which are similar to those of a hockey stick and which, therefore, can be met by the same materials as those found suitable for the hockey stick.

It is a general object of the present invention to make a blade of hockey stick of a non-wooden material and to form a hockey stick with such blade, which finds acceptance by the professional hockey players.

It is another general object of the present invention to make a blade of hockey stick which meets the afore-mentioned requirements and characteristics of a wooden blade as now used by the professional players.

It is a more specific object of the present invention to provide a blade of the above type which favorably competes with the conventional wooden blade, in particular with regard to impact resistance, relative weight or density, wear resistance, resilience and which is relatively easier to manufacture particularly in view of the required lateral curvature.

It is another object of the present invention to provide a moldable core which is particularly suited to form a blade of hockey stick in cooperation with a fiberglass shell and, in other words, which allows to meet the afore-mentioned requirements of the professional hockey stick.

It is another object of the present invention to produce a blade of hockey stick which does not produce a resented metallic sound upon impact.

It is still another object of the present invention to produce a blade of hockey stick which includes fiberglass reinforcement arranged to avoid unnecessary fibers and weights by using a fiberglass fabric with a majority of fibers extended lengthwise of the blade.

The above and other objects and advantages of the present invention will be better understood with the following detailed description of a preferred embodiment thereof which is illustrated, by

way of example, in the accompanying drawings, wherein:

Figure 1 is a longitudinal section through a blade of hockey stick made according to the present invention;

Figure 2 is a perspective view of the blade of Figure 1 with opposite lateral faces partially peeled off to show the core of the blade; and

Figure 3 is a cross-sectional view taken transversely of the blade as seen along line 3-3 in Figure 2.

The illustrated blade of hockey stick includes a core 1 which is molded with the outline of a conventional blade using a syntactic foam composition made of a thermosetting polyester, short independent fibers of polyester and hollow glass microspheres.

The core is reinforced at the heel portion, the tip portion, the bottom edge and the top edge by a string of non-porous thermoset or plastic polyester extending around the blade and defining a heel reinforcement 2, a tip reinforcement 3, a bottom reinforcement 4 and a top reinforcement 5.

A shell is provided to laterally confine the core 1. This shell includes a pair of faces 6 of fiberglass fabric adhered against the opposite lateral sides of the core 1. The fiberglass fabric is woven with at least 80% of the fibers in one direction and positioned such that this 80% or more of the fibers extends longitudinally of the blade. This is shown in Figure 2 by the fibers 7 which constitute at least 80% of the fabric and extend lengthwise of the blade while the fibers 8 constitute less than 20% of the fabric and extend substantially upright.

The core 1 is formed with a handle end 9 having a handle receiving cavity 10 extending downwardly and forwardly close to the bottom edge of the core, at the heel portion of the latter. A small passage 11 is formed through the core in communication with the bottom of

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the cavity 10.

The core 1 may be made with fibers of polyester, polyamide

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and/or fiberglass and with hollow microspheres of phenolic plastic and/or glass.

The blade is formed by compression molding, namely by pressing together two-half molds filled with the materials. One or more layers of fiberglass fabric of the afore-mentioned type are laid in one of the two-half molds, such that most of the fibers will extend lengthwise of the blade. These layers may be previously wetted with the resin, although this has not been found to be necessary.

In a particular embodiment of this invention, a ribbon of polyester resin in a gel form is laid on the fiberglass fabric around the periphery of the cavity in one-half mold, to form the heel, tip, bottom edge and top edge reinforcements 2, 3, 4, and 5 respectively. This ribbon is not essential.

The afore-mentioned core composition in viscous state is laid on top of the fabric and a metal insert is positioned in the mold to form cavity 10. Then, one or more layers of fiberglass fabric are laid on top of the core composition. After closing the mold and after curing at 130°C for about ten minutes at a molding pressure of between 500 and 800 p.s.i., and preferably about 500 p.s.i., the mold is opened and the solidified blade is trimmed, if necessary.

The handle 12 of the hockey stick is secured by any suitable adhesive in the cavity 10. The orifice 11 allows escape of any excess adhesive from the bottom of the handle receiving cavity 10. A high tensile strength glass fiber yarn 13 may be wound either only around the joint between the handle and the blade and/or around this joint and also the full length of the blade to prevent delamination, if so desired. However, this has been found to be unnecessary.

According to a preferred embodiment, the faces 6 are preferably made of a fiberglass fabric having at least 90% of the fibers 7 extending longitudinally of the blade.

The best results have been obtained with the following limitations:

the short, independent polyester fibers represent between 0.5 and 10% of the core by volume;

the hollow microspheres contribute at least 50% of the void spaces of the core; and

at least 80% of the fiberglass fibers extends longitudinally of the blade.

The blade made according to the present invention typically weighs about 117 grams, as compared to 121 grams for the conventional wooden blade.

The blade of the present invention is easily and cheaply molded and may have a preselected lateral rigidity by mere adjustment of the length of one layer of fiberglass fabric.

The use of a majority of longitudinally extending fiberglass fibers allows to reduce the weight of the blade by as much as 20% without reducing the resistance of the blade.

The short fibers used in the core and/or the woven layers defining the shell of the composite structure or laminate may be made of high tensile strength fibers other than polyester fibers. However, they must have a comparable percent elongation and no brittleness to impart to the core the desired impact resistance. For instance, polyamide fibers or aramide fibers, such as those known under the registered trade mark "KEVLAR", owned by DuPont of Canada Ltd., can be used. The following are preferred and non-limitative examples of the core composition.

EXAMPLE I

	% by weight
polyester resin	80%
benzoyl peroxide (catalyst)	2%
organo silane ester (coupling agent to promote adhesion of the resin to the microspheres)	1%
polyester fibers of between 0.1 and 0.5% long	8%
microspheres made of glass and of 75 microns in average diameter and average wall thickness of 1.5 micron (supplied under the registered trade mark "Eccosphere" type IG25, owned by Emerson	

	% by weight
& Cuming Inc.	9%
	100%

EXAMPLE II

Polyester resin formulation (including resin, catalyst and coupling agent)	80%
polyester fibers as in Ex. I	8%
microspheres as in Ex. I	12%
	100%

EXAMPLE III

Polyester resin formulation	80%
polyester fibers as in Ex. I	7%
microspheres as in Ex. I	9%
macrospheres made of epoxy resin and of a diameter range of 0.07 to 0.15 inch known under type EP-100 and above-mentioned registered trade mark "Eccosphere"	4%
	100%

EXAMPLE IV

Polyester resin formulation	70%
polyester fibers as in Ex. I	10%
microspheres as in Ex. I	20%
	100%

EXAMPLE V

Polyester resin formulation	65%
polyester fibers as in Ex. I	7%
microspheres as in Ex. I	28%
	100%

Further core compositions have also been prepared and tested in which the polyester resin compositions of the above examples

was replaced by an epoxy resin formulation and the microspheres were made of phenolic resin instead of glass.

It has been found that the preferred % ranges of the ingredients of the core composition are as follows:

resin	60% - 93% by weight
short fibers	2% - 15% by weight
spheres	5% - 25%

The laminates obtained in accordance with the invention have been found to be at least four times more resistant to impact than known laminates of equal weight and rigidity.

By varying the percentage weight of the short fibers in the core from zero to 15%, it has been found that Izod impact tests give values increasing from zero to 5.8 ft lbs/inch.

By increasing the loading of microspheres from 18% to 30%, the resulting decrease in density was about 10% and there was substantially no change in the Izod impact strength and the flexural modulus.

Thus, by using the core of the invention, it has been found that a hockey blade is obtained, which is of a quality superior to blades made of the best grade wood as to weight, stiffness and impact resistance, and is simpler and less expensive to manufacture and has uniform characteristics contrary to wood. Comparative impact tests using a puck-like weight dropped on the center of the blade supported at both ends, have shown that the blades of the invention regularly resist to an impact of 35 ft/lbs, whereas most wooden blades reinforced with fiberglass fabric break under an impact of 25 to 30 ft/lbs.

A blade of the invention weighs about 113 grams, compared to 120 grams for a wooden blade of the same size.

The afore-described composite reinforced structure, including the shell and the core or the latter alone, may be used with advantage to form other sport equipments, such as oars, paddles, skis, etc.

EXAMPLE VI

A hockey blade has been made as follows:

Fiberglass rowing, made by Bay Bills Ltd. under code No.

352-380-6002 of 13 ounces per square yard, was cut as follows:

a) 2 pieces of 3½" x 12"

b) 2 pieces of 2" x 8"

c) 1 piece of 1½" x 4"

one piece c), one piece b) and one piece a) were laid in the bottom half of a mold in superposed relationship with piece c) laid from the blade heel towards the handle. The insert for cavity 10 was positioned and the resin composition in properly measured amount was poured over the rovings. Then, the second pieces b) and a) were laid in superposed relation over the resin. The top half of the mold was closed. The composition was heated at ~~110~~ 130°C for about 10 minutes to cure the resin and the cured blade was removed from the mold. The molding pressure was about 500 p.s.i.

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The cured blade weighed 131 grams and, after trimming of its perimeter, it weighed 105 grams.

The fiberglass rovings were covered by the resin composition at all faces of the blade.

The resin composition used was as follows:

% by weight	
62.70%	80 parts of (rigid) polyester resin (Reichold Polylite polyester resin I.C. 338)
15.67%	20 parts of (less rigid) polyester resin (Reichold Polylite No. 31830)
12.54%	16 parts of microspheres "Eccosphere" type I.G. 25
6.67%	8½ parts of short fibers, high tenacity polyester fibers (6 deniers per filament) of tire cord grade sold under registered trade mark "DACRON" of DuPont Canada Ltd.
0.78%	1 part organo silane ester (adhesion promoter) sold by Union Carbide Canada Limited under code A-174
0.86%	1.1 part benzoyl peroxide (catalyst) sold under registered trade mark "CADOX", owned by Noury Chemical Corporation
.78%	1 part white pigment
100%	127.6

The use of two grades of polyester resin is to adjust the rigidity of the final product.

No filler other than the microspheres was used.

No reinforcing ribbon to make reinforcements 2, 3, 4, and 5 was used, as the blade was found to have sufficient resistance to breakage at the edges.

A wooden soft wood handle was inserted in cavity 10 and adhered therein by means of polyester resin.

A molded coating of polyester resin was then applied onto both main faces of the handle, said resin being reinforced with glass fiber yarn extending longitudinally of the handle. Both the resin and the yarn extended over the heel portion of the plastic blade to thus cast resin directly over the already cast resin of the blade by using a straight mold for receiving the handle and the heel portion of the blade. To achieve this, it was found necessary to heat to 110°C at least the heel portion of the blade containing cavity 10 and intended to be covered by the resin of the handle. Coating of the handle as above was made in accordance with the method described in Canadian Patent Application Serial No. 207,171, filed August 16, 1974, inventors Marcel Goupil, Gaston Ruel and Marc Ruel.

Thus, a unitary hockey stick with a very strong joint between the blade and the handle was obtained in a quick and inexpensive manner but which had superior qualities as to lightness, impact resistance and rigidity, as compared to conventional fiberglass fabric reinforced wooden hockey sticks of good quality.

Another blade was made as above but, while slightly changing the orientation of the insert to form cavity 10, a wooden handle was then inserted in cavity 10 and coated as above described and further by molding resin to the two narrow faces of the stick joining with the blade so as to obtain straight narrow faces longitudinally of the handle. Thus, it was found possible to obtain hockey sticks in which the angle between the blade and the handle varies to suit individual players' requirements while using the same molds for the blade and for the stick.

A Reverting to the composition of the blade core, it has been found that in the above examples, the ~~blade~~ core had a density of 0.8 as compared to a density of 1.23 when no microspheres are present. In

addition, the microspheres have been found to increase the impact resistance of the blade. This is understandable since the microspheres are somewhat elastic and flatten under impact. Fillers other than microspheres have been tested and found to degrade the mechanical properties of the blade.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED,ARE DEFINED AS FOLLOWS:

1- A syntactic foam composition having high impact resistance, said composition comprising a substantially uniform mixture of polyester resin, short independent fibers and small diameter thin walled hollow glass spheres, the short fibers being selected from the group consisting of polyamide, aramide and polyester fibers and capable of appreciable elongation under stress, said fibers having a length varying between 0.1 and 0.5 inch, the thin walled hollow glass spheres having an average diameter of about 75 microns, the polyester resin being in an amount varying between 60% and 93%, the short fibers being in an amount varying between 2% and 15% and the hollow spheres being in an amount varying between 5% and 25% by weight of the total syntactic foam composition.

2- A composition as claimed in claim 1, wherein said glass spheres have an average wall thickness of about 1.5 micron.

3- A composition as claimed in claim 1 or 2, wherein said short fibers are polyester fibers.

4- A composite reinforced article having enhanced impact resistance comprising an elongated thin core having two opposite main faces and narrow edge faces, said core made of a syntactic foam composition consisting of a mixture of polyester resin with short independent fibers and small diameter thin walled hollow glass spheres with the fibers and spheres substantially uniformly dispersed in the resin, the short fibers being selected from the group consisting of polyamide, aramide and polyester fibers and capable of appreciable elongation under stress, said fibers having a length varying between 0.1 and 0.5 inch, the thin walled hollow glass spheres having an

average diameter of about 75 microns, the polyester resin being in an amount varying between 60% and 93%, the short fibers being in an amount varying between 2% and 15% and the hollow spheres being in an amount varying between 5% and 25% by weight of the total syntactic foam composition, and a reinforcing shell for said core including at least one layer of woven fiberglass fabric applied to and adhered to the opposite main faces of the core with at least 80% of the glass fiber of the woven fabric extending lengthwise of said elongated core, the polyester resin of the core serving to adhere the woven fabric to the core.

5- An article as claimed in claim 4, wherein said short fibers are polyester fibers.

6- An article as claimed in claim 4 or 5, wherein said glass spheres have an average wall thickness of about 1.5 micron.

7- An article as claimed in claim 4 or 5, constituting the blade of a hockey stick.

8- A composite reinforced article as claimed in claim 4, wherein said core and said shell form a blade of a hockey stick and said core is molded with a handle-receiving cavity, and further including an elongated wooden handle of rectangular cross-section fitted and adhered within said cavity at one end, molded coatings of thermoset resin adhered to at least both faces of said handle parallel to the blade faces, said coatings overlapping the face portions of said blade opposite said cavity and adhering to said polyester resin of said core, said molded coatings containing high tensile strength reinforcing fibers or monofilaments embedded therein and extending longitudinally of the handle.

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9- A structure as claimed in claim 8, wherein the two remaining faces of said handle are covered by coatings of thermoset resin overlapping and adhering to the corresponding edge face portions of said blade opposite said cavity.

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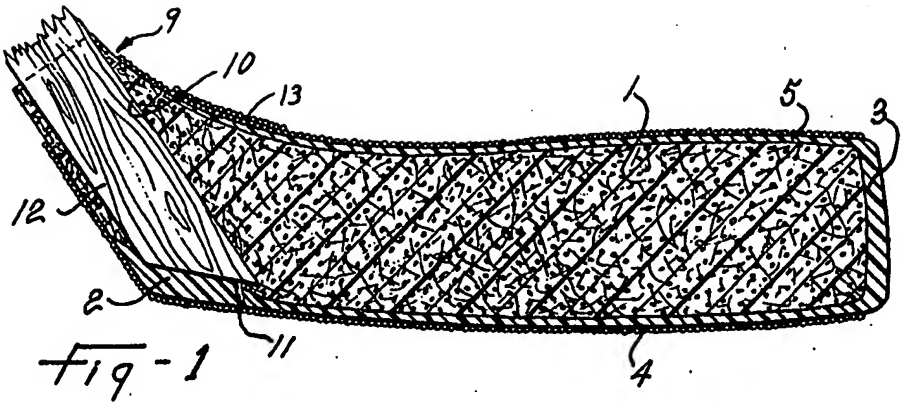

Fig - 1

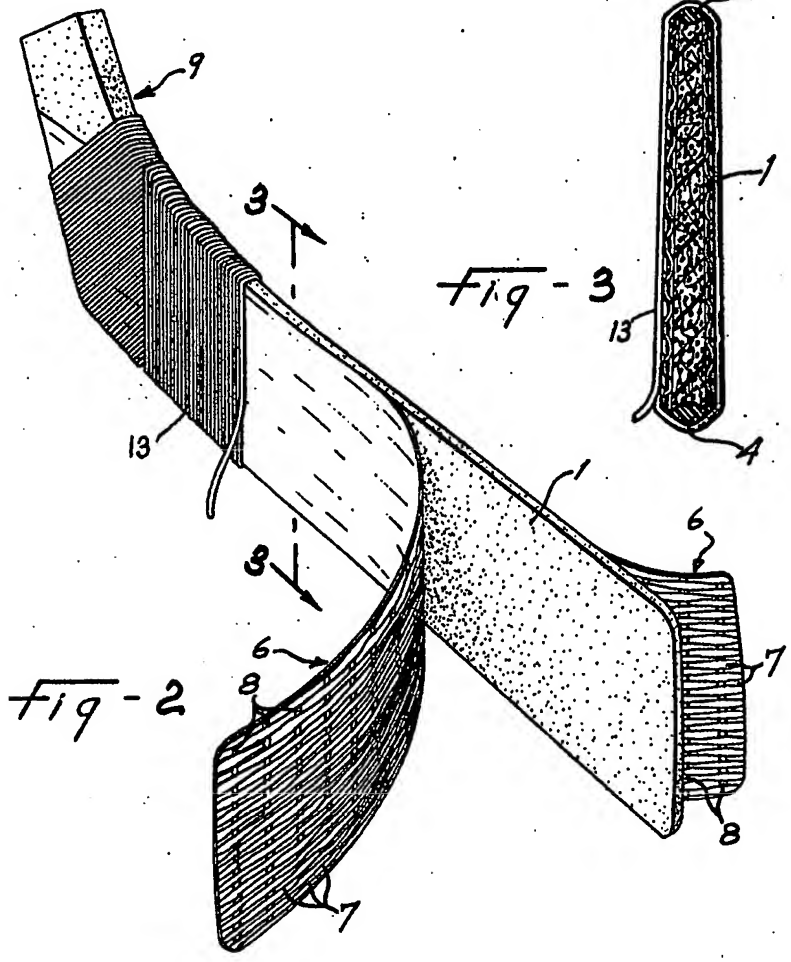

Fig - 2

Fig - 3

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